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Status of Atlantic Salmon (*Salmo salar* L.) Populations in Crabbes and Robinsons Rivers, and Middle Barachois, Fischells and Flat Bay Brooks, Newfoundland, 2001.

État des populations de saumon atlantique (*Salmo salar* L.) dans les rivières Crabbes et Robinsons ainsi que dans les ruisseaux Middle Barachois, Fischells et Flat Bay, à Terre-Neuve, en 2001.

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Abstract

Adult Atlantic salmon were visually counted in Middle Barachois Brook, Crabbes River, Robinsons River, Fischells Brook, and Flat Bay Brook in 2001. The surveys were conducted primarily by crews of 2 to 12 snorkellers floating down the main stem of each river. An adjustment factor, between 1.00 to 1.20, was applied to the counts in each river section to account for fish not observed. The estimated total numbers of salmon that returned to each river were: Crabbes River, 688 small and 180 large salmon; Middle Barachois Brook, 937 small and 142 large salmon; Robinsons River, 1909 small and 232 large salmon; Fischells Brook, 248 small and 45 large salmon: and, Flat Bay Brook, 1150 small and 176 large salmon. The percentage of the egg deposition conservation requirements achieved were 53% for Crabbes River, 80% for Middle Barachois Brook, 142% for Robinsons River, 19% for Fischells Brook, and 71% for Flat Bay Brook. The egg depositions in 2001 were lower than in 2000 for all rivers except Robinsons River. All estimates are considered under-estimates since there was evidence that the upstream migration of some salmon was delayed due to low water levels and high water temperatures; and salmon entered the rivers after the visual surveys. The information available did not lend itself to forecasting the abundance of salmon in 2002. Two rainbow trout were observed in Flat Bay Brook. The origin of these rainbow trout is unknown.

Résumé

Des dénombrements visuels des saumons atlantiques adultes ont été effectués en 2001 dans les rivières Crabbes et Robinsons ainsi que dans les ruisseaux Middle Barachois Fischells et Flat Bay. Ces relevés ont été réalisés principalement par des équipes de 2 à 12 plongeurs en apnée qui se laissaient flotter dans le cours principal de chaque cours d'eau. Le nombre de saumons observés dans chaque tronçon a été corrigé par un facteur variant entre 1,0 et 1,2 pour tenir compte des poissons qui n'ont pas été aperçus. Voici les estimations de la remonte totale dans chaque cours d'eau : 688 petits et 180 grands saumons dans la rivière Crabbes; 937 petits et 142 grands saumons dans le ruisseau Middle Barachois; 1 909 petits et 232 grands saumons dans la rivière Robinsons; 248 petits et 45 grands saumons dans le ruisseau Fischells; 1 150 petits et 176 grands saumons dans le ruisseau Flat Bay. Les pourcentages de la ponte nécessaire à la conservation atteints dans chaque cours d'eau sont les suivants : 53 % dans la rivière Crabbes; 80 % dans le ruisseau Middle Barachois; 142 % dans la rivière Robinsons; 19 % dans le ruisseau Fischells; 71 % dans le ruisseau Flat Bay. La ponte a été moins élevée en 2001 qu'en 2000 dans tous les cours d'eau à l'exception de la rivière Robinsons. Toutes les estimations sont considérées comme étant des sous-estimations puisque des données montrent que la montaison de certains saumons a été retardée en raison des bas niveaux d'eau et des températures élevées de l'eau et que des saumons ont remonté les cours d'eau après les relevés visuels. Les données disponibles ne se prêtaient pas à la prévision de l'abondance du saumon en 2002. Deux truites arc-en-ciel d'origine inconnue ont été observées dans le ruisseau Flat Bay.

Introduction

Atlantic salmon (*Salmo salar* L.) populations in Bay St. George rivers declined in the 1970's (Porter and Chadwick 1983) and have been below conservation levels for most of the past 30 years (Reddin and Mullins, 1996). The total returns to rivers appear to have only marginally increased with the closure of the commercial fisheries in 1992. Direct measurements of salmon population sizes in most rivers are difficult to obtain using conventional fish counting facilities due to the large size of the rivers and their extreme range in discharge.

Reddin and Mullins (1996) conducted assessments of the salmon populations in rivers in Bay St. George, used angling catch statistics and estimates of angling exploitation rates to estimate population sizes. Snorkelling surveys have been used to estimate the numbers of large and small salmon spawners in several rivers in Bay St. George since 1996 (Bourgeois et al. 1997; Porter 1997, 1999, 2000a, and 2001; and Porter and Bourgeois 1998). These surveys indicated generally higher populations of salmon in recent years than in the late 1980's and early 1990's. The salmon populations in Robinson's River and Flat Bay Brook appear to be higher relative to their threshold conservation egg deposition requirements than Crabbes River, Middle Barachois, and Fischells brooks.

Snorkelling surveys were again conducted in 2001, to obtain estimates of small and large salmon in Crabbes and Robinsons rivers, and Middle Barachois, Fischells and Flat Bay brooks (Figs 1-5). This document is an assessment of the status of the salmon populations in these rivers. The physical characteristics of these five rivers are described in Table 1.

Fisheries Management Measures

In 1978, restrictions were placed on the commercial and recreational fisheries in response to a decline in returns of salmon to Bay St. George rivers (Chadwick et al 1978). Further reductions were placed on the commercial fishery in the 1980's, and it was eventually closed in 1992. The retention of large salmon in the recreation fishery has been prohibited since 1984. The changes in the seasons and quotas in the recreational fisheries since 1953 are shown in Table 2. In 1992 and 1993 there were Salmon Fishing Area (SFA) quotas for the recreational fisheries, but the quota for SFA 13, which includes Bay St. George was only reached in 1992. Flat Bay Brook was closed to all angling in 1995 and 1996, and Fischells Brook was closed in 1999 and 2000. Angling is periodically closed each year due to high water temperatures and low water levels. Such was the case in 2001, when Crabbes River, Middle Barachois Brook, Robinsons River, and Flat Bay Brook were closed to angling August 3-27.

Methods

Recreational Fisheries data

Angling data were available from the salmon angler licence stub in 2001 (see O'Connell *et al.*1998 for a description of the methodology). The angling data for 1996 to 2000 were updated (Appendices 1-5).

Unrecorded mortalities

An estimate of all fish killed or naturally died before spawning is important for any stock assessment. Illegal activities do occur on the rivers being assessed; however, no quantitative estimates of salmon mortality are available. The percentage of salmon that will die due to being hooked and released by anglers will vary with handling techniques and water temperature (Anon 1998; Dempson et al 2002; Wilkie et al., 1996; and Brobbel et al, 1996). Mortality of hooked-and-released salmon at water temperatures below 20° C is expected to be less than 10%, if fish are handled properly. This value was applied to the estimated number of salmon released for the five rivers assessed.

Biological characteristics

For Crabbes and Robinsons rivers and Fischells Brook, the mean weights (1.63 kg for small, 5.06 kg for large) and percentage female (71.9% for small, 86.8% for large salmon) used in this assessment are values for years 1992-94 from Table 6a and b in Reddin and Mullins (1996) (Table 3). The mean weight, mean length and percent female for the salmon population in Middle Barachois Brook are those obtained from 34 large salmon and 71 small salmon sampled in Middle Barachois Brook, in August 1998 (Porter 2000a). The estimated mean fecundity of 1540 eggs/kg of body weight used by Porter & Chadwick (1983) was also used for Crabbes and Robinsons rivers, and Fischells and Middle Barachois brooks

For Flat Bay Brook, biological characteristics data were available for fish taken as broodstock in 1994-96 and from the angling fishery in 1994 (Table 3) (Bourgeois et al. 1997). These values were used in this assessment except for percent female for small salmon, which was taken from Reddin and Mullins (1996). A length-fecundity relationship for salmon in Flat Bay Brook was developed from samples taken as broodstock in 1995 and 1996 (Porter and Bourgeois 1998).

The percentage of large and small salmon in each river, used in this assessment, is the percentage observed in the survey in 2001.

Conservation spawning requirements

Spawning requirements for Atlantic salmon represent an estimate of the number of eggs (or spawners) required for conservation of the stock (O'Connell & Dempson 1995). Juvenile salmon rear in both fluvial and lacustrine habitat and thus spawning requirements are based on the number of eggs required for both types of habitat (O'Connell & Dempson 1995). The habitat accessible to sea-run salmon in Crabbes and Robinsons rivers, and Middle Barachois, Fischells and Flat Bay brooks is primarily fluvial with little lacustrine habitat (Table 1). Therefore, in relation to the fluvial habitat, the production of parr in lacustrine habitat would be small but still important.

Conservation egg deposition requirements for the five rivers being assessed are those calculated by Reddin & Mullins (1996) as target eggs (Table 1). The conservation requirements in terms of numbers of spawners requires knowledge of the proportion of the conservation egg deposition level that should come from large and small salmon. Since these rivers are believed to historically have had a significant component of virgin 2SW salmon, it is uncertain how to determine the appropriate number of large salmon that should be in the spawning population to meet its conservation requirements. The populations are currently at low levels; thus, the observed proportions of large and small salmon may not be the appropriate composition for conservation of the large salmon component. Estimate of the large and small salmon conservation requirements were calculated by Porter and Bourgeois (1998) but were not recommended for use as minimum threshold limits for fisheries management due to the above mentioned uncertainties.

Survey Methodology

In 2001, Atlantic salmon were visually counted in Middle Barachois Brook 7-8 August, in Crabbes River 9, 10 and 12 August and September 28, in Robinsons River 9, 10, 13, and 14 August, in Fischells Brook 12-14 August, and in Flat Bay Brook 11-13 August. The counts were conducted by surveyors who snorkelled down sections of the main stem of each river that were believed to be accessible to anadromous salmon, The water levels were sufficiently low on Crabbes River that the gorge (Section 5) could be surveyed for the second consecutive year. Also, modifications to the survey procedures enabled the large pool at the base of the falls on Robinsons River to be surveyed. Little Crabbes River, tributary of Crabbes River and Northern Feeder, tributary of Robinsons River, were surveyed in 2001. Salmon generally enter these small tributaries later in the year when water discharges increase. Few salmon were observed in the tributaries during surveys in previous years. Water levels in all rivers were low when surveyed.

The main stem of each river was divided into sections with each section generally being less than 10 km in length (Figs 1-5). The procedures used in conducting the surveys in 2001 were similar to those previously reported by Porter (1999, 2000a, and 2001) and Porter and Bourgeois (1998) with the following modifications:

1) The numbering of sections was changed, such that the Sections were numbered consecutively beginning with Section #1 in the estuary. The start and finish points of each section were kept consistent with previous years.

2) Section 4 and 5 of Flat Bay Brook were completely surveyed, instead of using a helicopter to ferry the crew between pools as done in previous years, to ensure few fish went undetected.
3) The pool at the base of the falls, Section 4 Robinsons River is too deep for snorkellers to see the bottom. Ten snorkellers were used to survey the pool. A rope was strung across the river and at 2.5m intervals a 4m-long rope made up of 2m of nylon spliced to 2m of lead rope was suspended in the water column. Snorkellers lined up across the horizontal rope at equal intervals and floated down river. This technique herded the salmon to shallower (<3m) in the downstream end of the pool; where, they were counted as they swam upstream under the rope.
4) A new section was added to Middle Barachois above Section 4, where fish have been observed for the last 2 years.

A survey crew, comprising of snorkellers and recorders, was assigned to each river Section. Crews varied in size from two (2) to 16 people, with a minimum of two (2) and a maximum of 12 snorkellers per crew. The snorkellers would passively float or swim downstream and count salmon with one or two recorders walking along the riverbank and record the information. A rope was frequently stretched across the river and held in place by two recorders, or snorkellers. The snorkellers would line up across the river along the rope such that there was total underwater visual coverage, both horizontally and vertically. The recorders would slowly walk down river with the snorkellers holding onto the rope. Snorkellers would all look underwater in the same direction across the river and count the salmon that passed between himself/herself and the adjacent surveyor. This technique proved to be very effective and greatly increased the confidence in the estimates of the number of fish in the larger pools. If snorkellers were unsure of the count, they would float through the pool a second or third time. When two or more passes were made through the same pool, the highest count was recorded except in circumstances where the numbers of fish were estimated, in which case the average was recorded. Water depths in many riffle areas were too shallow for swimming, particularly in the upper sections of each river. In these sections observations were made by snorkellers while walking downstream. Adult salmon are infrequently found in shallow water at this time of the year.

In each Section, surveyors consecutively numbered pools where salmon were observed. When salmon were observed the pool number and the appropriate map cell number were recorded in a field notebook along with the number of large and small salmon, number of salmon with net marks or other injuries, and a description of the pool.

Number of Spawners and Total Returns to Rivers

An adjustment factor was applied to the number of salmon counted in each river Section to account for unobserved salmon. Some of the pools were too deep or too wide to obtain a complete count of salmon and in some sections visibility was reduced. Also, there may have been small numbers of salmon in tributaries. The adjustment factor was determined subjectively in consultation with the snorkellers, taking into consideration the number and size of the pools in which complete counts could not be ascertained, and the number of salmon counted in adjacent pools. The rationale for choosing each adjustment factor is provided in Appendix 6.

There are many factors that affect accuracy and precision of the counts by individuals and collectively by the teams. These factors include water depth and width of pools, turbidity and colour of water, angle of sun, and light conditions in general. No adjustments were made to the counts to compensate for possible inaccuracies of counts or precision of estimates by individuals or teams. However, for the second consecutive year a test was conducted to evaluate the ability of the snorkellers to accurately count wooden model "test salmon" and categorise them as large (>63 cm) or small (<63 cm) in an experimental situation. Although the test results provides some insight into the accuracy of counting and sizing of salmon, it is not possible with stationary wooden fish to duplicate the conditions under which salmon are enumerated during the survey. Thus, the results were not used in this assessment; however, a description of the test and the results are given in Appendix 7.

The adjusted numbers of large and small salmon represent the total numbers in each river at the time of the survey, and assumed to approximate the spawning escapement. It is believed that the majority of spawners had entered the river prior to the survey and there is no information available on mortalities after the survey.

The total returns to each river was obtained by adding the number of salmon retained in the recreational fishery and 10% of the number of salmon hooked-and-released to the estimated spawning escapement. No adjustment was made for illegal removals.

Egg Deposition

The unadjusted and adjusted egg deposition (ED_{ua} & ED_a) for Crabbes River, Middle Barachois Brook, Robinsons River, and Fischells Brook, in 2001, were calculated for small and large salmon separately then summed as follows:

(1) $$ED_{ua} = (UN_S * PF_S * RF_S * MW_S) + (UN_L * PF_L * RF_L * MW_L)$$

(2) $$ED_a = (AN_s * PF_S * RF_S * MW_S) + (AN_L * PF_L * RF_L * MW_L)$$

Where:
$UN_{S\ or\ L}$ = unadjusted numbers of small or large salmon counted in the survey
$PF_{S\ or\ L}$ = percent female small or large salmon
$RF_{S\ or\ L}$ = relative fecundity for small or large salmon (1540 eggs/kg)
$MW_{S\ or\ L}$ = mean weight for small or large salmon
$AN_{S\ or\ L}$ = adjusted number of small or large salmon counted in the survey

The unadjusted and adjusted egg deposition (ED_{ua} & ED_a) for Flat Bay Brook, in 2001, were calculated for small and large salmon separately then summed as follows:

(3) $$ED_{ua} = (UN_S * PF_S * F_{FS}) + (UN_L * PF_L * F_{FL})$$

(4) $$ED_a = (AN_s * PF_S * F_{FS}) + (AN_L * PF_L * F_{FL})$$

Where: $F_{FS \text{ or } FL}$ = fecundity of small or large salmon for Flat Bay Brook based on length/fecundity relationship, y = 173.02x - 6266.8 (Porter and Bourgeois 1998).

Percentage of Conservation Level Achieved

The adjusted and unadjusted percentage of the conservation egg deposition levels achieved in each river in 2001 were calculated as follows:

(5) Percentage of conservation level achieved = $(ED_{ua \text{ or } a} / CED) * 100$

Where: CED = Conservation Egg Deposition requirements

Results

Recreational Fisheries Data

The angling catches in 2001 for Crabbes River, Middle Barachois Brook, Robinsons River, Fischells Brook and Flat Bay Brook, as compiled from the angling licence stub returns, and estimated angling mortality are provided in Table 4. The catch statistics from 1996-2001 are provided in Appendices 1-5. Angling data for years prior to 1996 can be found in Porter et al (2001). However, data prior to 1996 may not be directly comparable to the data derived from the license stub returns because the methodologies differ.

Crabbes River

There were 46 small and 42 large salmon hooked-and-released on Crabbes River in 2001, which is equivalent to an exploitation of 6.7% and 23.3% of the total returns of small and large salmon respectively to the river (Table 4).

Middle Barachois Brook

There were 26 small and nine (9) large salmon hooked-and-released on Middle Barachois Brook in 2001 which is equivalent to an exploitation of 2.8% and 6.3% of the total returns of small and large salmon respectively to the river (Table 4).

Robinsons River

Anglers retained 106 and hooked-and-released 268 small salmon, and hooked-and-released 134 large salmon on Robinsons River in 2001. The combined catch of small salmon is equivalent to an exploitation of 19.6% of the total returns of the small salmon. The hook-and-released catch of large salmon is 57.8% of the total returns of large salmon (Table 4). The overall angling mortality of small salmon was 133 fish equivalent to 7.0% of the total returns to the river (Table 4).

Fischells Brook

Anglers retained 34 and hooked-and-released three (3) small salmon, and hooked-and-released seven (7) large salmon on Fischells Brook in 2001. The combined catch of small salmon is equivalent to an exploitation of 14.9% of the total returns of the small salmon. The hook-and-released catch of large salmon is 15.6% of the total returns of large salmon (Table 4). The overall angling mortality of small salmon was 34 fish equivalent to 13.8% of the total returns to the river (Table 4).

Flat Bay Brook

Anglers retained 170 and hooked-and-released 280 small salmon, and hooked-and-released 34 large salmon on Flat Bay Brook in 2001 (Table 4). The combined catch of small salmon is equivalent to an exploitation of 39.1% of the total returns of the small salmon; whereas, the catch of large salmon is 19.3% of the total returns of large salmon. The overall angling mortality of small salmon on Flat Bay Brook was 198 fish equivalent to 17.2% of the total returns to the river (Table 4).

Number of Spawners and Total Returns to Rivers

Salmon were generally concentrated in a small number of pools in each river. Few salmon were found in riffles or in pools less than one (1) meter in depth, except in locations with cooler spring-fed water. In river sections that have few pools and when water levels are medium height, some salmon are in riffle areas near large rocks and boulders. Densities greater than 10 salmon were found in 12 pools in Crabbes River, 13 pools on Middle Barachois Brook, 15 pools in Robinsons River, five (5) pools in Fischells Brook, and 13 pools on Flat Bay Brook (Tables 5 to 9). The unadjusted and the adjusted numbers of small and large salmon counted in the five (5) rivers are provided in Tables 5 to 9 respectively. The overall adjustment factors for the counts of salmon in each river ranged from 1.06 for Fischells Brook to 1.13 for Flat Bay Brook (Tables 5-9). The adjusted counts of small and large salmon are assumed to be the number of spawners since there were no known removals subsequent to the survey. A summary of the estimated spawning escapements to these five rivers, 1996-2001, is provided in Table 10, and the estimated total returns in Table 11.

Crabbes River

The water levels were low in Crabbes River in 2001, which provided an opportunity to survey the gorge (~1 km long) in Section 5 for the second time since snorkeling surveys were initiated in 1996. The water conditions were such that a complete coverage (depth and width) could be made of all pools in the gorge, 12 small salmon were observed. River Monitors surveyed Little Crabbes River in late August, but no salmon were observed. However, 80 fish were observed in Little Crabbes River near the Trans Canada Highway bridge on September 28.

The total number of spawners estimated to be in Crabbes River in 2001 was 859 salmon, of which 683 (79%) were small and 176 (21%) were large salmon (Table 5). Section 4 of Crabbes River contained the greatest number (299) of salmon; and, Section 3 contained the highest percentage (31%) of large salmon (Table 5). The spawning escapement of small salmon in 2001 is the second lowest estimate since surveys began in 1996, and is 18% lower than the average

number of small salmon spawners 1996-00 (Table 10). The spawning escapement (176) of large salmon, in 2001, is the second lowest observed since surveys began in 1996 and is 29% lower than the average spawning escapement 1996-00. The annual estimated total returns of small and large salmon to Crabbes River, 1996-2001, are provided in Table 11.

Middle Barachois Brook

Water levels were very low when Middle Barachois Brook was surveyed. Salmon were distributed throughout Sections 2 to 5, but none were seen in Section 1 (Table 6). Fifty-three percent (53%) of the salmon were observed in Section 2. The highest percentage (36%) of large salmon was found in Section 5. No tributaries were surveyed in 2001.

The total number of spawners in Middle Barachois Brook in 2001 was estimated to be 1075 salmon, of which 934 (87%) were small salmon and 141 (13%) were large salmon (Table 6). The spawning escapement of small Atlantic salmon in 2001 was 5% higher than the 1996-00 average escapement (Table 10). The spawning escapement of large salmon was 28% higher than the average escapement 1996-00. The annual estimated total returns of small and large salmon to Middle Barachois Brook, 1996-2001, are provided in Table 11.

Robinsons River

In Robinsons River, 56% of the salmon were located in Sections 4. The highest percentage (13%) of large salmon was found in Section 2. A survey of Northern Feeder was conducted and a total of 19 small salmon were observed.

The total number of spawners in 2001 was estimated to be 1995 salmon, of which 1776 (89%) were small salmon and 219 (11%) were large salmon (Table 7). The spawning escapement of small salmon in 2001 is 59% higher than the average escapement 1996-00 (Table 10). The spawning escapement of large salmon is 8% higher than in the average escapement 1996-00. The annual estimated total returns of small and large salmon to Robinsons River, 1996-2001, are provided in Table 11.

Fischells Brook

In Fischells Brook, 48% of the salmon were found in Section 4 (Table 8). No tributaries were surveyed in 2001.

The total number of spawners in 2001 was estimated to be 257 salmon, of which 214 (83%) were small salmon and 44 (17%) were large salmon (Table 8). Spawning Escapement of small salmon in 2001 was 78% lower than the average escapement 1996-00 (Table 10). The spawning escapement of large salmon was 74% lower than the average escapement 1996-00. The annual estimated total returns of small and large salmon to Fischells Brook, 1996-2001, are provided in Table 11.

Flat Bay Brook

In Flat Bay Brook, 44% of the spawning escapement was located in Section 2 and 34% in Section 5. The highest percentage (27%) of large salmon occurred in Section 5.

The total number of spawners in 2001 was estimated to be 1125 salmon, of which 952 (85%) were small salmon and 173 (15%) were large salmon (Table 9). The spawning escapement of

small salmon in 2001 was 43% lower than the average escapement 1996-00 (Table 10). The spawning escapement of large salmon was 29% lower than the average escapement 1996-00 (Table 10). The total estimated returns of small and large salmon to Flat Bay Brook, 1996-2001, are provided in Table 11.

Two rainbow trout (*Oncorhynchus mykiss)*, which are non-indigenous to the river, were observed during the survey in a pool in Section 2.

Egg Deposition

The estimated egg deposition and percentage of conservation level achieved in 2001 are provided in Table 12, and summarized below. Estimates of the percentage of the conservation egg deposition levels achieved in each of the five rivers, 1996-2001, are provided in Table 13 and Figure 6.

River	Egg Deposition	% Conservation achieved
Crabbes River	$2.4*10^6$	53
Middle Barachois Brook	$1.7*10^6$	80
Robinsons River	$4.7*10^6$	142
Fischells Brook	$0.7*10^6$	19
Flat Bay Brook	$2.7*10^6$	71

External Marks or Scars

The numbers of salmon observed with external marks, which include net marks and other injuries, and the percent of total number of fish observed from 1997 to 2001, are shown below. The percent in parenthesis is the percent of the total number of salmon observed.

River	1997	1998	1999	2000	2001
Crabbes River	13 (1.1%)	13 (3.2%)	10 (1.4%)	28 (2.7%)	15 (1.9%)
M. Barachois Brook	9 (0.8%)	N/A	10 (1.8%)	47 (4.0%)	18 (1.8%)
Robinsons River	22 (2.1%)	N/A	5 (0.4%)	4 (0.3%)	52 (2.9%)
Fischells Brook	10 (1.7%)	2 (0.9%)	5 (0.4%)	13 (0.7%)	7 (2.8%)
Flat Bay Brook	17 (1.3%)	N/A	12 (0.6%)	12 (0.8%)	23 (2.3%)

Discussion

Water levels were particularly low and visibility was very good on all rivers when the surveys were conducted, which resulted in greater confidence in the numbers of salmon enumerated, as reflected in the low adjustment factors (Tables 5 to 9). However, there was evidence that low water levels and high water temperatures delayed the entry of some salmon into rivers until late August or early September, after the snorkel surveys were completed (August 14). River Monitors did not observe any salmon in Little Crabbes River, a tributary that enters Crabbes River near its estuary, during a survey in late August, but on Sept 28, they observed 80 salmon. On Highlands River, which is the adjacent river south of Crabbes River, 80.0% of total returns of salmon passed a fish counting fence after August 15, compared to 40.5% during the same period 1996-2000 (Table 14). Thus, it would appear that the low water levels caused about 50% of the salmon that normally enter Highlands River prior to August 15 to delay river entry until after that date. There is no information to confirm that this percentage can be applied to other rivers. On August 28, Section 1, of Fischells River was re-surveyed and 24 salmon were counted, which is two (2) less than was counted when this Section was surveyed on August 12. There is no apparent valid means to estimate the numbers of salmon entering the rivers after the surveys were conducted. Thus, estimates of the spawning escapements, total returns, and egg depositions for 2001 must be considered underestimates (Tables 10, 11, and 12).

A test conducted in 2001 to evaluate snorkeller biases in counting and categorizing salmon into small (<63 cm) and large (>63 cm), indicated a wide range in differences among individuals, particularly for large salmon (Appendix 7). The majority of the snorkellers counted fewer "test" large salmon and more small salmon than were actually present. However there was very little difference between the total number of test fish counted and the actual number. The average number of large "test salmon" counted was 13.3% less than the actual number, and the average number of small "test salmon" counted was 3.0% more. The total number of small and large "test salmon" counted was 1.5% less than the actual number. Only one of the nine snorkellers obtained a count greater than the actual total number of "test salmon". These biases were not used to adjust the numbers of salmon counted in the spawner surveys because of the uncertainty of applying biases in counting model "test salmon" to counting real salmon. During actual

survey conditions, salmon move when approached by the surveyor, which may cause it to be more easily detected than "test salmon". However, it can be concluded that snorkellers tend to underestimate the total number of large salmon. This apparent bias is consistent with providing a minimum estimate of the number of spawners in each river. Bias by snorkellers in counting large numbers of fish and categorizing their size needs to be further examined. Bias is difficult to determine due to differences in water conditions such as turbidity, water depth, watercolor, angle of the suns rays, and light intensity throughout a river and between rivers. Bias may also be related to individual snorkeller differences such as quality of sight including peripheral vision, and attention span.

The total returns and spawning escapements of small Atlantic salmon in Crabbes River have considerable annual variability (Table 10 and 11). Although the returns (180) of large salmon in 2001 is slightly higher than the returns in 2000, it is 29% lower than the average returns 1996-2000, and maintains the downward trend since 1997 (Table 11). The low spawning escapement of large and small salmon, in 2001 is of concern. The egg deposition in 2001 was estimated to be 53% of the river's threshold conservation level, which is below the 2000 and average 1996-00 values (Table 13, Fig. 6).

The conservation egg deposition level (80%) achieved in Middle Barachois Brook in 2001 was 16% lower than estimated for 2000 and 13% higher than the estimated average level 1996-00 (Table 13, Fig. 6). There was considerable fluctuation in spawning stock size over the five (5) years that spawner counts have been estimated, possibly caused by the severe fluctuations in water levels and temperatures that occur in this river. Porter (2000a) provides a detailed summary of the biological characteristics of salmon from Middle Barachois River sampled in 1998. It is of interest to note that 26.7% of the virgin 2 SW salmon were in the small category measuring between 60 cm and 62.5 cm in fork length. All of the 2 SW salmon, in this size range, were females. The small size of the 2 SW salmon in Middle Barachois Brook is undoubtedly related to the early run timing of these salmon. Some salmon are known to enter Middle Barachois Brook and several other rivers in Bay St. George in late April and early May; therefore, they would not have the opportunity to increase in size after their last winter at sea. **Thus, when a retention fishery opens on Middle Barachois Brook, it would be appropriate to permit only retention of salmon <60 cm in fork length, if the management objective is to minimize angling mortality of 2 SW salmon. Similar consideration would be appropriate for all early run salmon rivers in Bay St. George.**

The spawning escapement of small salmon (1776) and egg deposition estimated for Robinsons River in 2001 is the highest recorded since the visual spawner surveys were initiated in 1996 (Tables 10 and 13). In contrast the spawning escapements of small salmon, and egg depositions estimated for Fischells Brook and Flat Bay Brook declined in 2001 (Tables 10 and 13). The returns of large salmon to Fischells Brook and the percentage of the conservation requirements achieved in 2001 are the lowest recorded since the spawner surveys were initiated in 1997. The egg deposition level achieved in Flat Bay Brook in 2001 is 57% lower than in 2000.

Robinsons River, Fischells Brook and Flat Bay Brook were open for a 2-week retention angling in 2001. The number of small salmon (106) retained in the 2-week season on Robinsons River is 51% lower than the catch (215) in the 14-week season in 1995 (Appendix 3). The number of

small salmon (170) retained on Flat Bay Brook in 2001 is 16% higher than retained in 2000 (Appendix 5), which is inconsistent with the 52% decline in total returns (Table 11). The estimated mortality of small salmon attributed to angling is 7%, 14% and 17% of the total returns of small salmon to Robinsons River, and Fischells and Flat Bay brooks respectively in 2001 (Table 4). The estimated mortality of large salmon on these rivers attributed to angling ranged from 1% to 6%. .

It is anticipated that a 2-week retention-angling fishery could occur on Robinsons River and Flat Bay Brook in 2002 without negatively affecting the conservation egg deposition levels, given the recent increasing trends in returns. However, no angling mortality should be permitted on Fischells Brook in 2002, given the low egg deposition in 2001 and the extreme variation in returns observed in previous surveys, 1997-2001 (Table 13).

The annual proportions of large salmon in the spawning escapements as estimated from the visual surveys are quite variable for all rivers when compared to previous years (see the text Table below). The percent large salmon in Robinsons River is the lowest observed in the time series.

	Percent large salmon					
	1996	1997	1998	1999	2000	2001
Crabbes River	22.1	23.6	26.2	24.9	12.9	20.5
Middle Barachois Brook	4.3	14.9	N/A	9.9	11.4	13.1
Robinsons River	13.5	14.5	N/A	13.5	19.6	11.0
Fischells Brook	N/A	10.8	27.0	18.1	13.3	17.0
Flat Bay Brook	9.7	11.5	N/A	10.5	17.9	15.4

A complete review of the biological characteristic database for these rivers is warranted.

The percentage of observed salmon with external marks in 2001 is the highest recorded for Robinsons River, and Fischells and Flat Bay brooks. Scars may have been caused by injuries from foul hooking, jigging, predator birds, or from fish hitting rocks during their upstream migration. The observations of scars on salmon by snorkellers are underestimates of the actual number, since it is difficult to see and keep account of marks when there are large numbers of fish in a pool.

The information available for this assessment does not lend itself to forecasting the abundance of salmon in 2002.

The origins of the two rainbow trout observed in Flat Bay Brook are not known. There has been no confirmed naturally reproducing population of rainbow trout in Bay St. George. Marine cage rearing of rainbow trout occurs in Bay d'Espoir, Newfoundland, Nova Scotia and Bay of Fundy, New Brunswick. Documentation of observations of rainbow trout in Newfoundland are provided in Porter (2000b).

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Table 1. Drainage area, fluvial habitat, and egg deposition levels required for conservation in five rivers in Bay St. George.

River Name	Drainage Area (sq. km)	Fluvial Rearing Units (100 sq. m)	Standing Water (ha)	Conservation Requirement Eggs (x106)
Crabbes River	551	18,429	381	4.6
Middle Barachois Brook	241	8,395	362	2.1
Robinsons River	439	13,491	124	3.3
Fischells Brook	360	13,661	948	3.6
Flat Bay Brook	635	16,012		3.8
Total	2,226	69,988	1,814	17.4

Table 2. Seasons and quotas, where applicable, for small salmon (< 63 cm) in the angling fishery for five rivers in SFA 13, 1953-99. Hook and Release only is indicated by H&R

Years	Crabbes	M. Barachois (Quota)	Robinsons (Quota)	Fischells (Quota)	Flat Bay (Quota)
1953-77	14 May –15 Sep	14 May –15 Sep	14 May –15 Sep	14 May –15 Sep	14 May –15 Sep
1978-84	1 Jul – 31 Aug	1 Jul – 31 Aug	1 Jul – 31 Aug	1 Jul – 31 Aug	1 Jul – 31 Aug
1985	8 Jun – 2 Sep	8 Jun – 2 Sep	8 Jun – 2 Sep	8 Jun – 2 Sep	8 Jun – 2 Sep
1986	1 Jun – 7 Sep	1 Jun – 7 Sep (350)	1 Jun – 7 Sep	1 Jun – 7 Sep	1 Jun – 7 Sep (400)
1987	1 Jun – 7 Sep	1 Jun – 7 Sep (350)	1 Jun – 7 Sep	1 Jun – 7 Sep	1 Jun – 7 Sep (300)
1988	1 Jun – 7 Sep	1 Jun – 7 Sep (175)	1 Jun – 7 Sep	1 Jun – 7 Sep	1 Jun – 7 Sep (300)
1989-94	1 Jun – 7 Sep	1 Jun – 7 Sep (175)	1 Jun – 7 Sep	1 Jun – 7 Sep (200)	1 Jun – 7 Sep (250)
1995	3 Jun – 17 Sep	3 Jun – 17 Sep (175)	3 Jun – 17 Sep	3 Jun – 17 Sep (200)	Closed
1996	1 Jun – 2 Sep (H&R)	1 Jun – 2 Sep (H&R)	1 Jun – 2 Sep (H&R)	1 Jun – 2 Sep	Closed
1997	1 Jun – 1 Sep (H&R)	1 Jun – 1 Sep (H&R)	1 Jun – 1 Sep (H&R)	1 Jun – 1 Sep	1 Jun – 1 Sep (H&R)
1998	6 Jun – 7 Sep (H&R)	6 Jun – 7 Sep (H&R)	6 Jun – 7 Sep (H&R)	6 Jun – 7 Sep (H&R)	6 Jun – 7 Sep (H&R)
1999	1 Jun – 7 Sep (H&R)	1 Jun – 7 Sep (H&R)	1 Jun – 7 Sep (H&R)	(Closed)	1 Jun – 7 Sep (H&R)
2000	1 Jun – 7 Sep (H&R)	1 Jun – 7 Sep (H&R)	1–23 Jun (H&R) 24 Jun – 9 Jul Retention fishery 10 Jul- 7 Sep (H&R)	(Closed)	1–23 Jun (H&R) 24 Jun – 9 Jul Retention fishery 10 Jul- 7 Sep (H&R)
2001	1 Jun – 7 Sep (H&R)	1 Jun – 7 Sep (H&R)	1–23 Jun (H&R) 24 Jun – 9 Jul Retention fishery 10 Jul- 7 Sep (H&R)	24 Jun – 9 Jul Retention fishery (H&R)	1–23 Jun (H&R) 24 Jun – 9 Jul Retention fishery 10 Jul- 7 Sep (H&R)

Table 3. Biological characteristics of salmon in five Bay St. George rivers.

River	Small salmon			Large salmon		
	% Female	Mean Wt(kg)	Mean Lth(cm)	% Female	Mean Wt(kg)	Mean Lgth(cm)
Crabbes River	71.9	1.63	N/A	86.8	5.06	N/A
Middle Barachois Brook	54.3	1.4	51.9	94.1	2.9	67.0
Robinsons River	71.9	1.63	N/A	86.8	5.06	N/A
Fischells Brook	71.9	1.63	N/A	86.8	5.06	N/A
Flat Bay Brook	71.9	1.34	53.4	66.7	3.31	69.1

Table 4. Number of salmon retained and released in the angling fishery on five Bay St. George rivers, 2001. Mortality is assumed to equal to the retained angled salmon plus 10% of the released salmon. Percent (%) of returns is the percent of total returns to the

	Crabbes		M. Barachois		Robinsons		Fischells		Flat Bay	
	No. of	% of returns	No. of fish	% of return	No. of fish	% of returns	No. of fish	% of returns	No. of fish	% of returns
Small Salmon										
Released	46	6.7	26	2.8	268	14.0	3	1.2	280	24.3
Retained	0	0.0	0	0.0	106	5.6	34	13.7	170	14.8
Estimated Mortality	5	0.7	3	0.3	133	7.0	34	13.8	198	17.2
Large Salmon										
Released	42	23.3	9	6.3	134	57.8	7	15.6	34	19.3
Retained	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Estimated Mortality	4	2.3	1	0.6	13	5.8	1	1.6	3	1.9

Table 5. Number of small and large salmon counted in Crabbes River, 9,10,12 August, 28 Sept. 2001.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adjusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	1	46	4	1.20	55	5	60	8.0
2	2	100	13	1.10	110	14	124	11.5
3	1	9	4	1.00	9	4	13	30.8
4	2	184	76	1.15	212	87	299	29.2
5	0	12	0	1.00	12	0	12	0.0
6	2	88	26	1.00	88	26	114	22.8
7	3	115	20	1.10	127	22	149	14.8
L Crabbes	1	64	16	1.10	70	18	88	20.0
TOTAL	12	618	159	1.11	683	176	859	20.5

Table 6. Number of small and large salmon counted in Middle Barachois Brook, 7, 8 August 2001.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adjusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	0	0	0	1.00	0	0	0	
2	4	452	58	1.10	497	64	561	11.4
3	5	264	30	1.10	290	33	323	10.2
4	2	107	24	1.05	112	25	138	18.3
5	2	28	16	1.20	34	19	53	36.4
Big Dribble	Not Surveyed					0	0	0.0
TOTAL	13	851	128	1.10	934	141	1075	13.1

Table 7. Number of small and large salmon counted in Robinsons River, 9,10,13, &14 August 2001

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adjusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	5	265	22	1.10	292	24	316	7.7
2	3	356	51	1.10	392	56	448	12.5
3	1	92	2	1.05	97	2	99	2.1
4	5	851	118	1.15	979	136	1,114	12.2
N. Feeder	1	18	1	1.00	18	1	19	5.3
TOTAL	15	1582	194	1.12	1776	219	1995	11.0

Table 8. Number of small and large salmon counted in Fischells Brook, 12-14 August 2001.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adjusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	1	26	1	1.00	26	1	27	3.7
2	0	4	1	1.00	4	1	5	20.0
3(Steadies)	2	69	14	1.10	76	15	91	16.9
4	2	93	25	1.05	98	26	124	21.2
5	0	10	0	1.00	10	0	10	0.0
TOTAL	5	202	41	1.06	214	44	257	17.0

Table 9. Number of small and large salmon counted in Flat Bay Brook, 11-13 August 2001

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adjusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	1	29	0	1.05	30	0	30	0.0
2	7	405	48	1.10	446	53	498	10.6
3	2	160	13	1.10	176	14	190	7.5
4	1	23	3	1.00	23	3	26	11.5
5	2	231	86	1.20	277	103	380	27.1
TOTAL	13	848	150	1.13	952	173	1125	15.4

* See Appendix 6

Table 10. Spawning escapements of Atlantic salmon to five Bay St. George rivers, 1996 to 2001. Table is an update from Porter (2001).

Year	Crabbes		M. Barachois		Robinsons		Fischells		Flat Bay	
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1996	844	239	805	36	768	120	N/A	N/A	1051	112
1997	1121	346	1044	182	1017	172	599	73	1282	167
1998	482	234	N/A	N/A	N/A	N/A	194	72	N/A	N/A
1999	709	263	560	66	1399	200	1264	246	2237	231
2000	1024	152	1142	155	1293	316	1800	276	2134	466
2001	683	176	934	141	1776	219	214	44	952	173
Mean 96-00	836	247	888	110	1119	202	964	167	1676	244

Table 11. Estimated total returns of Atlantic salmon to five Bay St. George rivers, 1996 to 2001. Table is an update from Porter (2001)

Year	Crabbes		Middle Barachois		Robinsons		Fischells		Flat Bay	
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1996	870	249	818	38	882	138	N/A	N/A	1233	132
1997	1168	361	1056	189	1107	195	863	89	1320	174
1998	494	239	N/A	N/A	N/A	N/A	205	72	N/A	N/A
1999	717	265	563	66	1452	204	1264	246	2276	235
2000	1027	156	1142	155	1501	320	1800	276	2397	494
2001	688	180	937	142	1909	232	248	45	1150	176
Mean 96-00	855	254	895	112	1236	214	1033	171	1807	259

Table 12. Adjusted and unadjusted numbers of small and large Atlantic salmon spawners, estimated egg deposition, and percentage of egg deposition required for conservation that was attained in five Bay St. George rivers, in 2001.

River	Small salmon		Large salmon		Egg deposition		% Conservation level	
	unadjusted	adjusted	unadjusted	adjusted	unadjusted	adjusted	unadjusted	adjusted
Crabbes River	618	683	159	176	2190832	2423131	48	53
M. Barachois Bk	851	934	128	141	1534193	1685995	73	80
Robinsons River	1582	1776	194	219	4167425	4686658	126	142
Fischells Brook	202	214	41	44	641892	683842	18	19
Flat Bay Brook	848	952	150	173	2381543	2691088	63	71

Table. 13. Percentage of the Atlantic salmon egg deposition level required for conservation that was achieved on five rivers in Bay St. George, 1996-01. Table is updated from Porter (2001).

Year	Crabbes	M. Barachois	Robinsons	Fischells	Flat Bay
1996	68	52	67	N/A	85
1997	95	95	91	44	89
1998	53	N/A	N/A	23	N/A
1999	66	43	118	110	149
2000	63	95	135	142	167
2001	53	80	142	19	71
Mean 96-00	69	71	103	80	123

Table 14. Percent of large and small Atlantic salmon entering Highland's River, Bay St. Georges after August 1 for years in which the fish countingfence was operating 1980 - 2000.

Period	Mean 80-82, 93-95	1996	1997	1998	1999	2000	2001	Mean 96-00	Mean 80-01
Aug. 1 to Oct. 31	39.7	38.7	30.6	46.0	60.8	63.4	80.0	47.9	46.5
Aug. 15 to Oct. 31	30.4	37.2	28.8	43.7	43.9	48.8	80.0	40.5	38.7
Sept. 1 to Oct. 31	22.2	36.1	28.6	16.9	10.4	43.1	36.4	27.0	25.4
Sept. 15 to Oct. 31	7.7	27.9	5.2	3.8	7.1	37.4	16.4	16.3	12.0

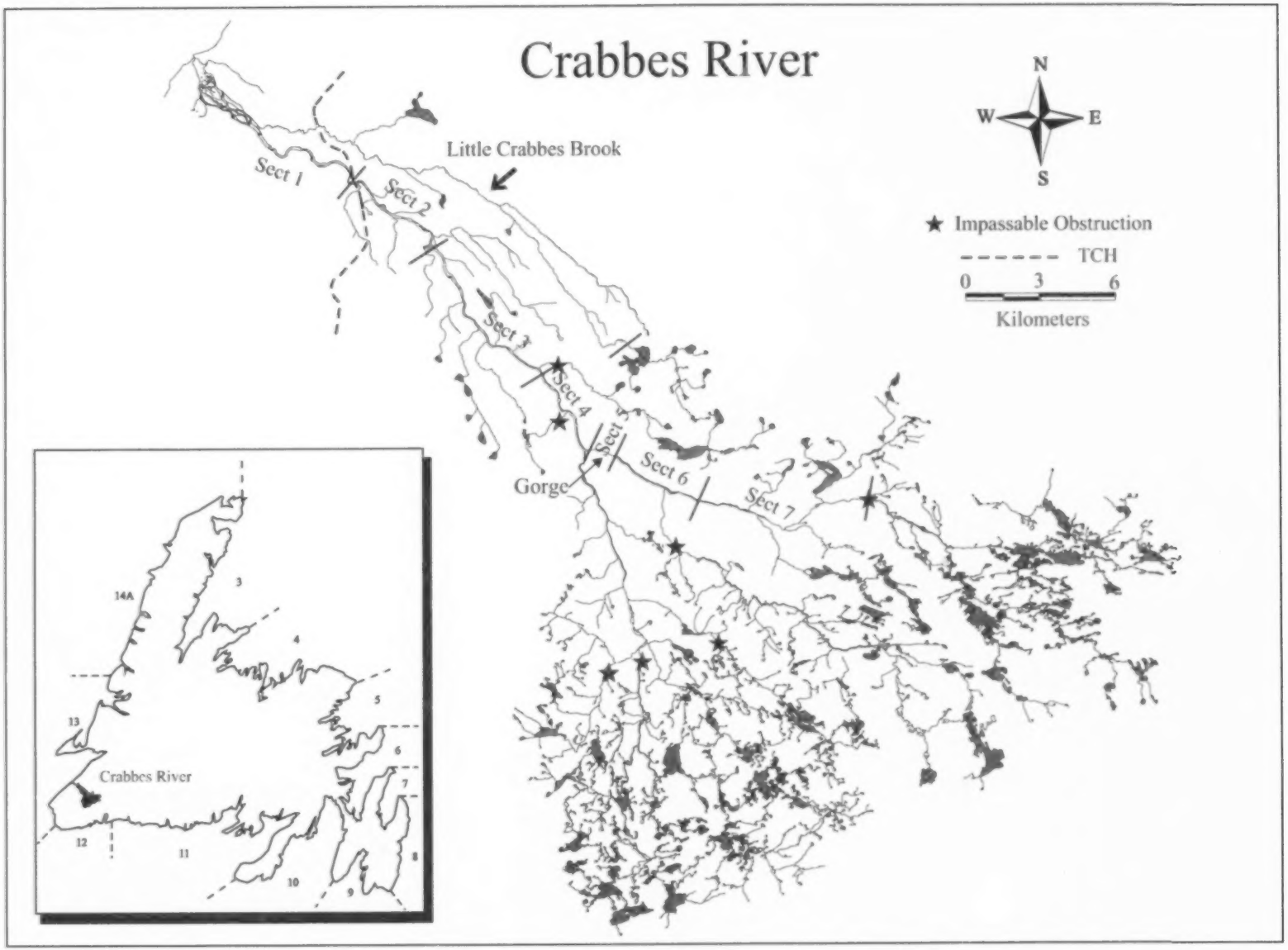

Figure 1. Map showing sections of Crabbes River in which visual surveys were conducted. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Crabbes River.

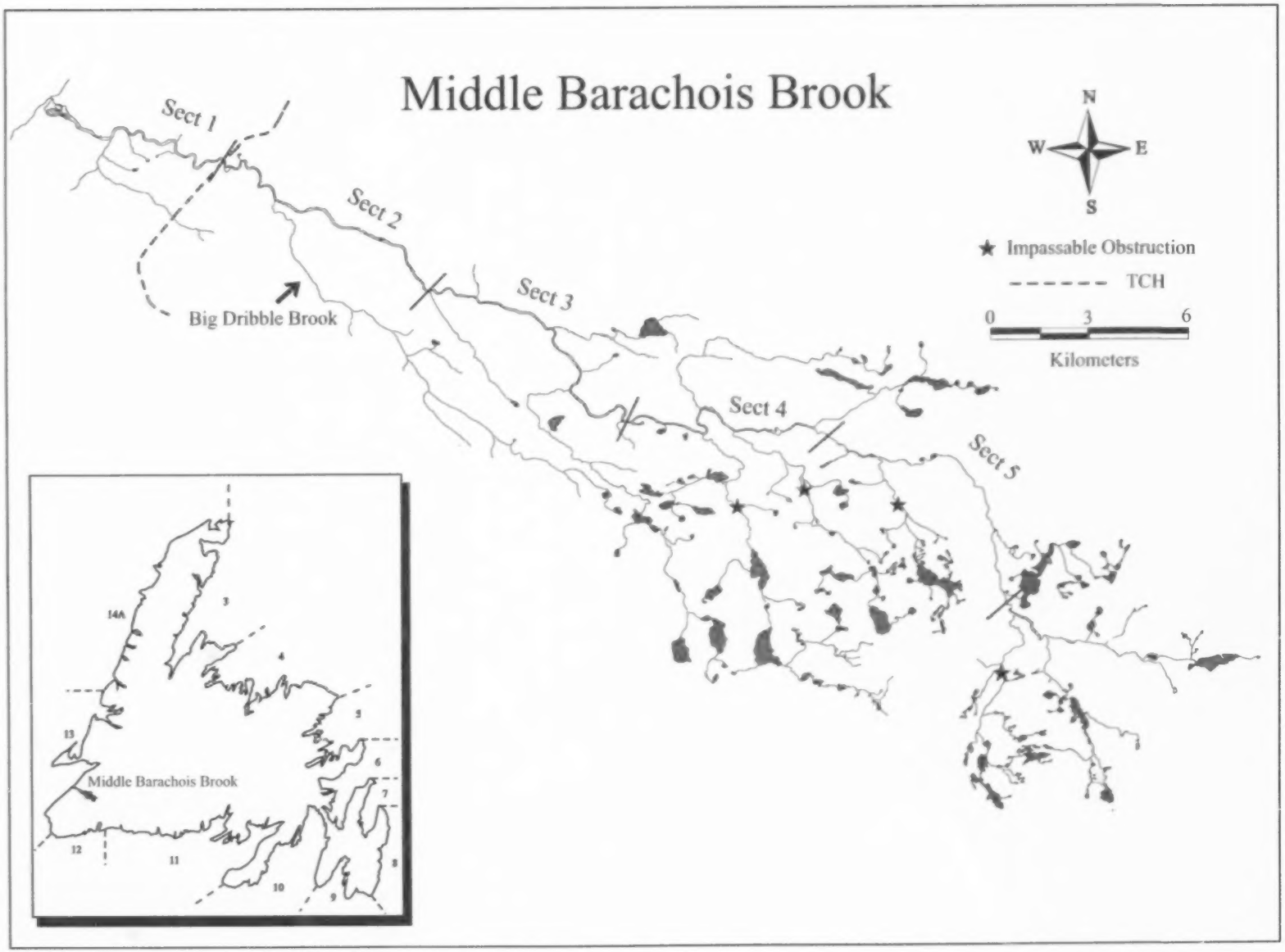

Figure 2. Map showing sections of Middle Barachois Brook in which visual surveys were conducted. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Middle Barachois Brook.

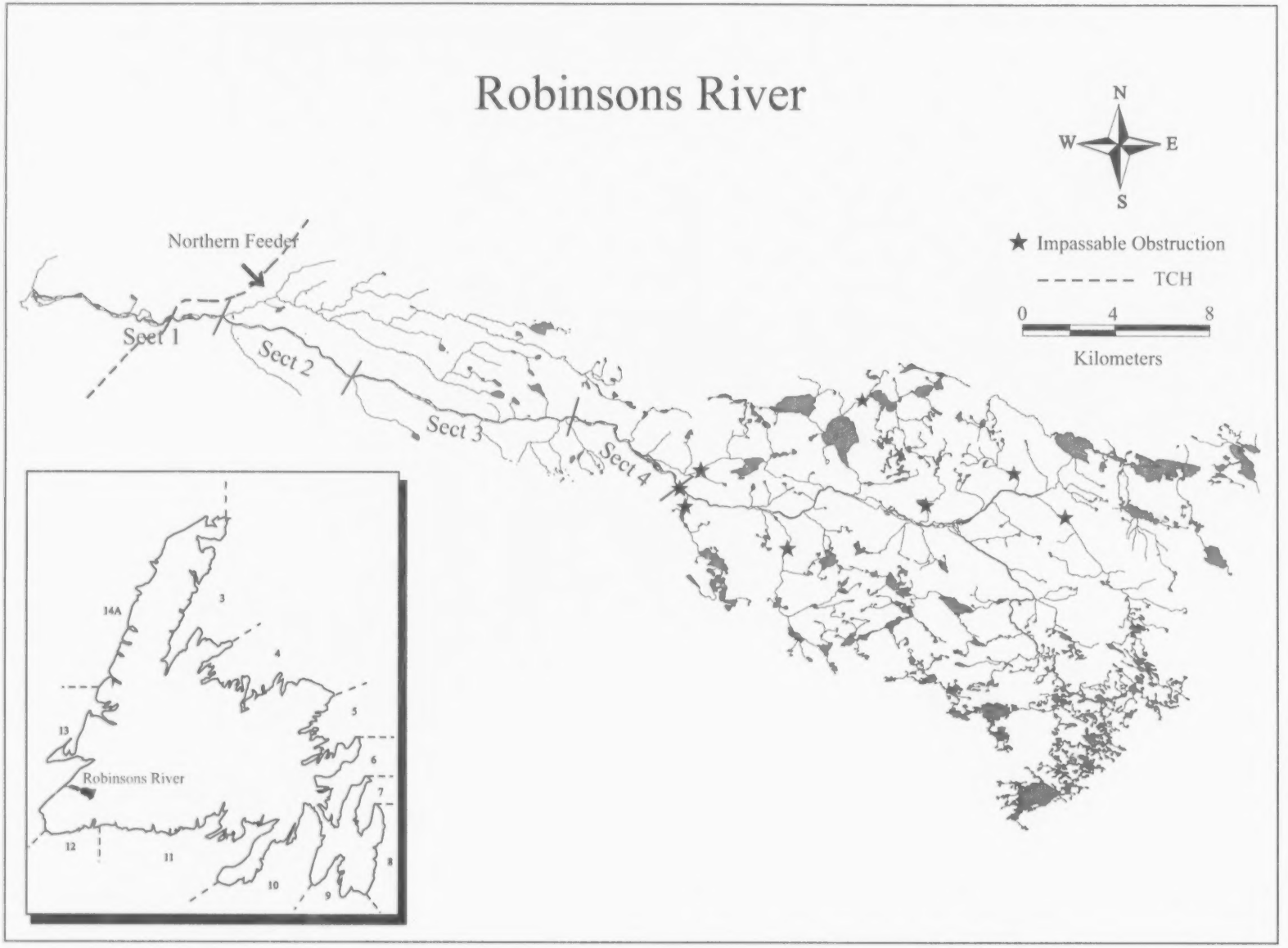

Figure 3. Map showing sections of Robinsons River in which visual surveys were conducted. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Robinsons River.

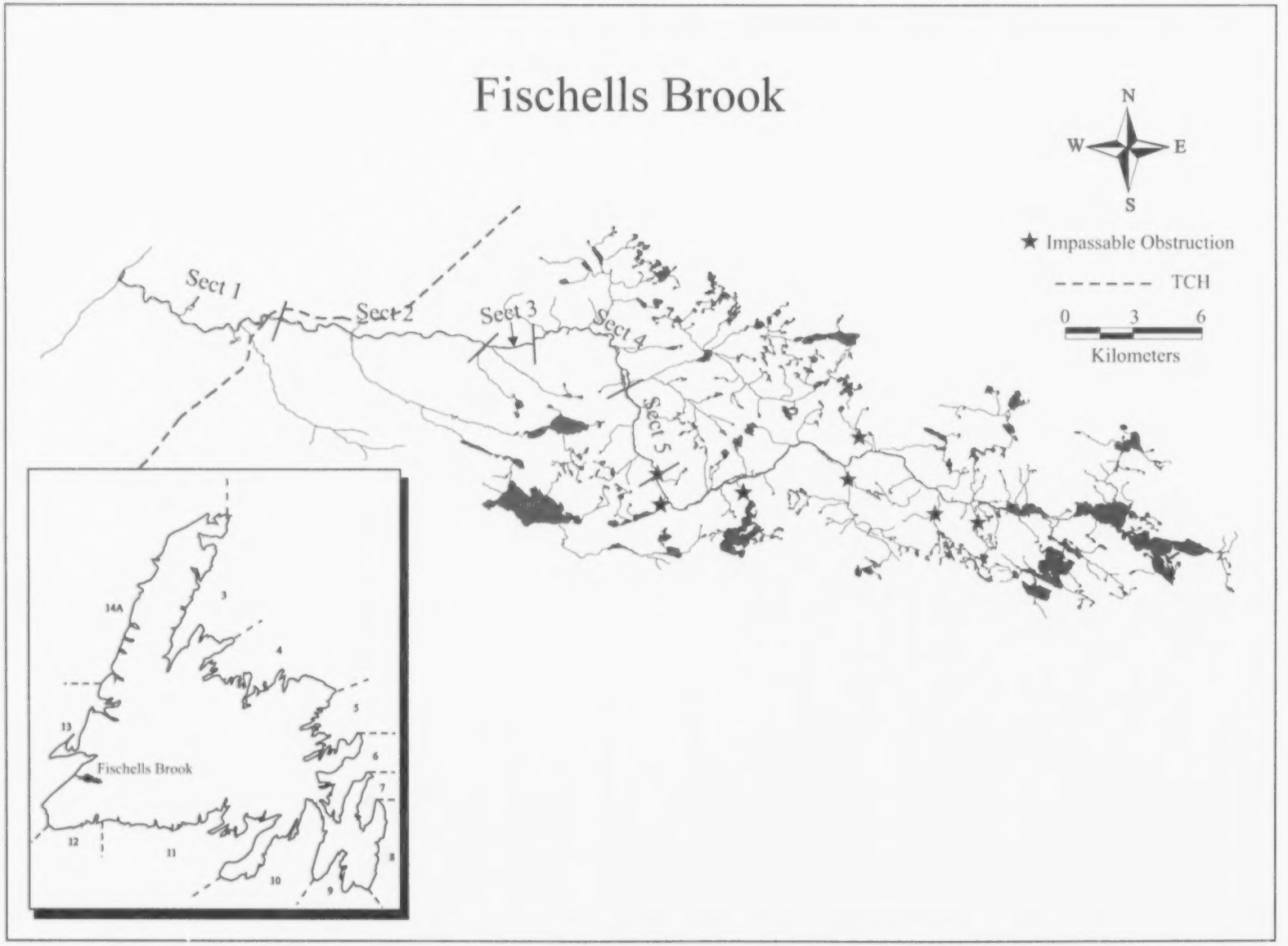

Figure 4. Map showing sections of Fischells Brook in which visual surveys were conducted. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Fischells Brook.

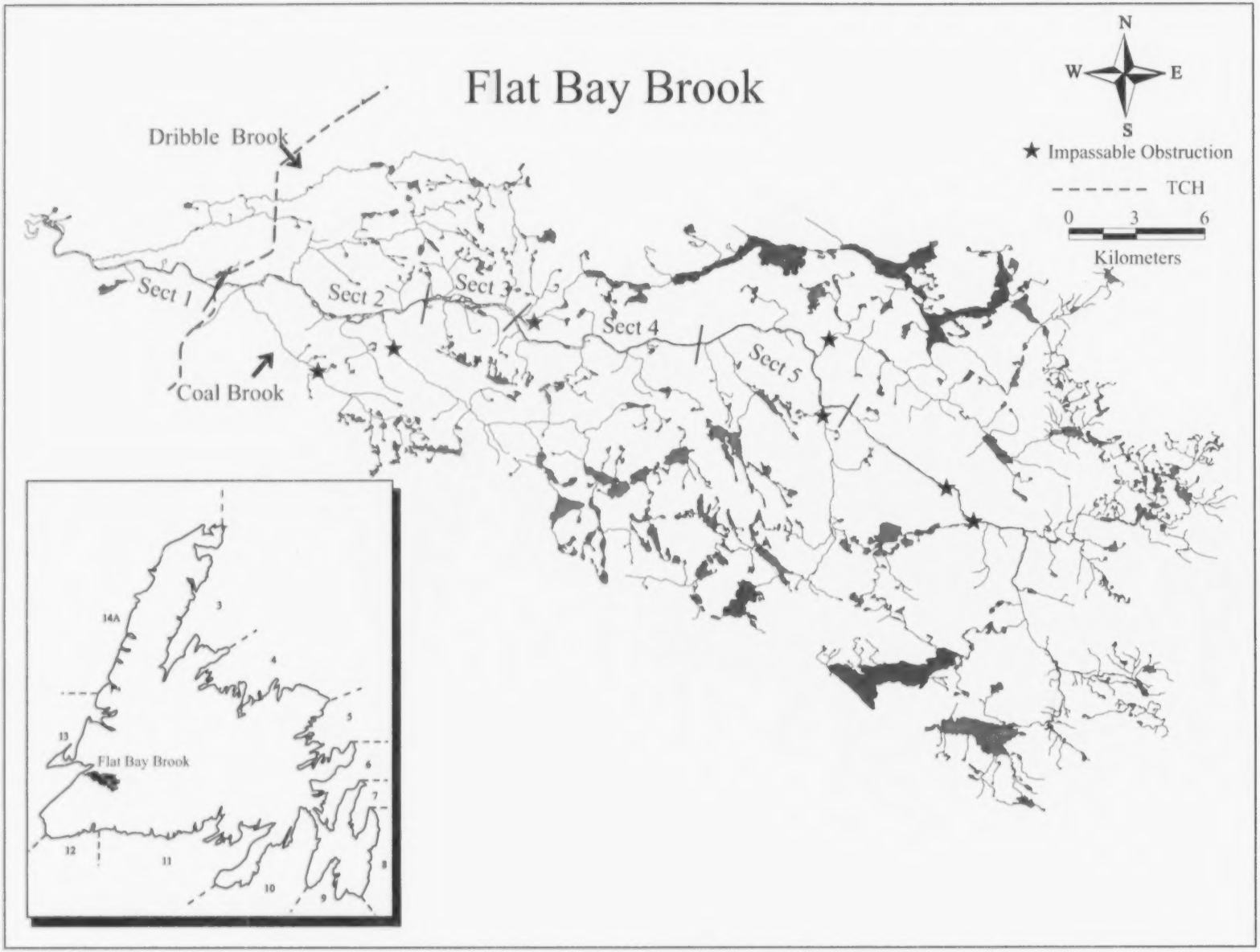

Figure 5. Map showing sections of Flat Bay Brook in which visual surveys were conducted. Inset shows the Salmon Fishing Areas in Newfoundland and the location of Flat Bay Brook.

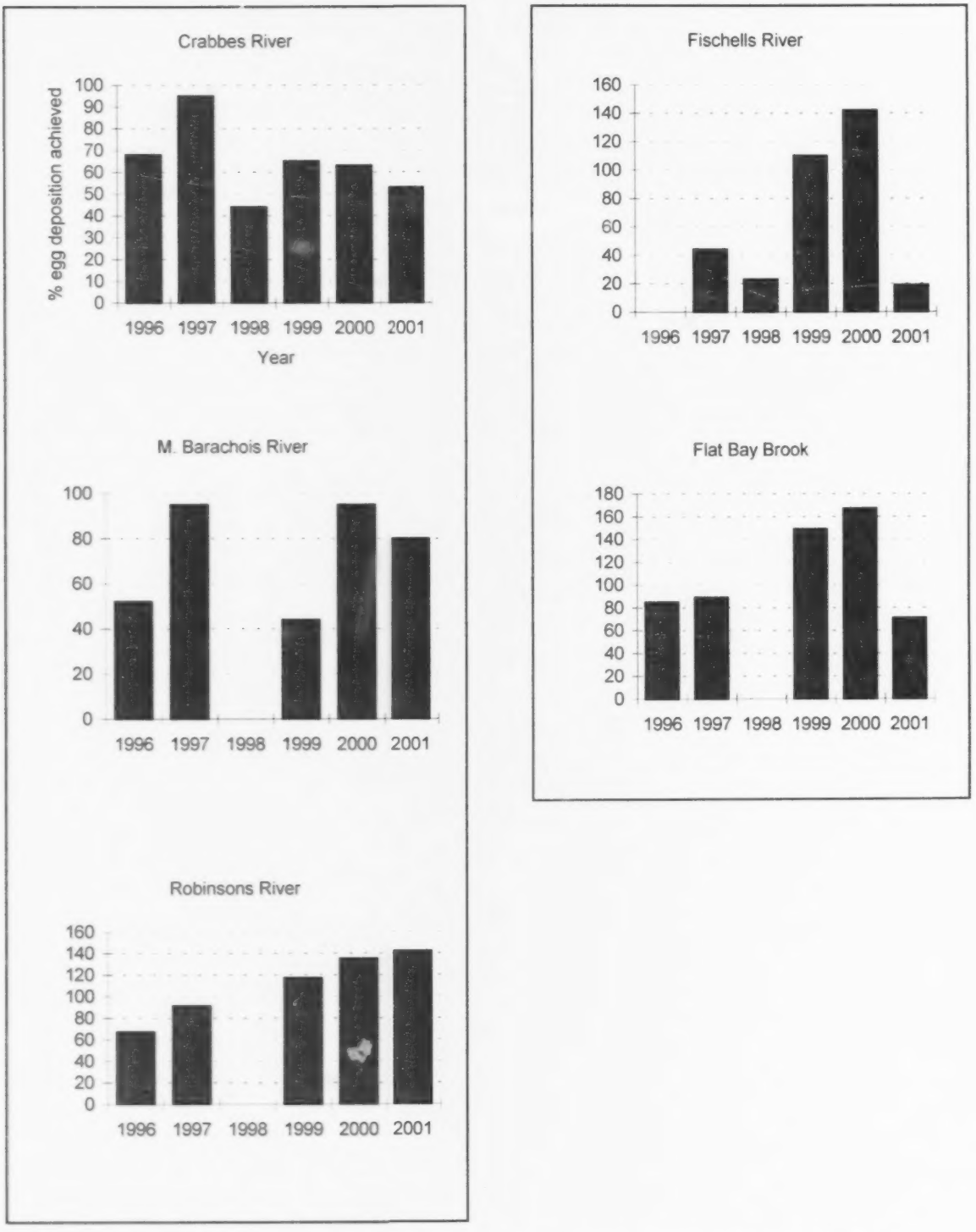

Figure 6. Percent of the Conservation Egg Deposition Requirements achieved, 1996-01.

Appendix 1. Anging catch statistics for Crabbes River 1994 to 2001 as derived from the Salmon Angling Stub Returns. River open only for hook-and-release angling 1996-2001.

	Effort	Small (<63 cm)			Large (≥63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1994	1014	207	278	485	*	266	266	207	544	751	0.74
1995	708	125	196	321	*	157	157	125	353	478	0.68
1996	319	0	260	260	*	102	102	0	362	362	1.13
1997	517	5	416	421	*	148	148	5	564	569	1.10
1998	379	0	121	121	*	51	51	0	172	172	0.45
1999	176	0	76	76	*	18	18	0	94	94	0.53
2000	110	0	31	31	*	42	42	0	73	73	0.66
2001	205	0	46	46	*	42	42	0	88	88	0.43
1994-2000 mean	460.4	48.1	196.9	245.0	.	112.0	112.0	48.1	308.9	357.0	0.8
95% CL	283.0	75.0	119.1	156.7	.	77.1	77.1	75.0	180.9	230.5	0.2
N	7	7	7	7	.	7	7	7	7	7	7

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS IN TERMS OF SMALL AND LARGE SALMON COMBINED (RETAINED + RELEASED FISH).
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

Appendix 2. Angling catch statistics for Middle Barachois Brook 1994 to 2001 as derived from the Salmon Angling Licence Stub returns. River closed to retention 1996-2001.

	Effort	Small (<63 cm)			Large (≥63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1994	909	168	107	275	*	87	87	168	194	362	0.40
1995	549	110	70	180	*	41	41	110	111	221	0.40
1996	208	2	119	121	*	19	19	2	138	140	0.67
1997	208	0	123	123	*	73	73	0	196	196	0.94
1998	24	0	9	9	*	0	0	0	9	9	0.38
1999	32	0	22	22	*	2	2	0	24	24	0.75
2000	6	0	3	3	*	0	0	0	3	3	0.50
2001	51	0	26	26	*	9	9	0	35	35	0.69
1994-2000 mean	276.6	40.0	64.7	104.7	.	31.7	31.7	40.0	96.4	136.4	0.6
95% CL	301.0	62.3	47.4	90.6	.	32.4	32.4	62.3	75.7	120.1	0.2
N	7	7	7	7	.	7	7	7	7	7	7

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS IN TERMS OF SMALL AND LARGE SALMON COMBINED (RETAINED + RELEASED FISH).
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.
HOOK & RELEASE ONLY 1996-2001.

Appendix 3. Angling catch statistics for Robinsons River 1994 to 2001as derived from the Salmon Angling Licence Stub returns. River open for only hook-and-release angling 1996-1999.

	Effort	Small (<63 cm)			Large (≥63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1994	1835	313	280	593	*	214	214	313	494	807	0.44
1995	1183	215	293	508	*	125	125	215	418	633	0.54
1996	915	5	1092	1097	*	179	179	5	1271	1276	1.39
1997	1027	5	853	858	*	230	230	5	1083	1088	1.06
1998	763	0	462	462	*	105	105	0	567	567	0.74
1999	509	0	529	529	*	38	38	0	567	567	1.11
2000	1530	153	553	706	*	44	44	153	597	750	0.49
2001	806	106	268	374	*	134	134	106	402	508	0.63
1994-2000 mean	1108.9	98.7	580.3	679.0	.	133.6	133.6	98.7	713.9	812.6	0.8
95% CL	405.4	115.1	264.7	204.4	.	69.1	69.1	115.1	291.8	244.1	0.3
N	7	7	7	7	.	7	7	7	7	7	7

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS IN TERMS OF SMALL AND LARGE SALMON COMBINED (RETAINED + RELEASED FISH).
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

Appendix 4. Angling catch statistics for Fischells Brook 1994 to 2001as derived from the Salmon Angling Licence Stub returns. River open to hook-and-release angling only in 1998, and closed to all angling 1999 and 2000.

	Effort	Small (<63 cm)			Large (≥63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1994	424	121	90	211	*	59	59	121	149	270	0.64
1995	318	93	48	141	*	44	44	93	92	185	0.58
1996	992	318	273	591	*	160	160	318	433	751	0.76
1997	844	240	242	482	*	159	159	240	401	641	0.76
1998	49	8	27	35	*	4	4	8	31	39	0.80
1999	0	0	0	0	*	0	0	0	0	0	0
2000	0	0	0	0	*	0	0	0	0	0	0
2001	60	34	3	37	*	7	7	34	10	44	0.73
1994-2000 mean	375.3	111.4	97.1	208.6	.	60.9	60.9	111.4	158.0	269.4	0.5
95% CL	363.8	112.6	102.0	213.6	.	63.6	63.6	112.6	165.3	276.8	0.3
N	7	7	7	7	.	7	7	7	7	7	7

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS IN TERMS OF SMALL AND LARGE SALMON COMBINED (RETAINED + RELEASED FISH).
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

Appendix 5. Angling catch statistics for Flat Bay Brook 1994 to 2001as derived from the Salmon Angling Licence Stub re River closed all angling in 1996 and open to hook-and-release angling only 1997-1999

	Effort	Small (<63 cm)			Large (≥63 cm)			Total (Small + Large)			
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE
1994	1689	375	148	523	*	117	117	375	265	640	0.38
1995	17	8	4	12	*	0	0	8	4	12	0.71
1996	0	0	0	0	*	0	0	0	0	0	0
1997	524	0	378	378	*	71	71	0	449	449	0.86
1998	229	0	139	139	*	80	80	0	219	219	0.96
1999	338	0	389	389	*	36	36	0	425	425	1.26
2000	1148	146	1165	1311	*	276	276	146	1441	1587	1.38
2001	739	170	280	450	*	34	34	170	314	484	0.65
1994-2000 mean	563.6	75.6	317.6	393.1	.	82.9	82.9	75.6	400.4	476.0	0.8
95% CL	564.0	127.5	362.5	403.7	.	85.2	85.2	127.5	440.1	485.8	0.4
N	7	7	7	7	.	7	7	7	7	7	7

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS IN TERMS OF SMALL AND LARGE SALMON COMBINED (RETAINED + RELEASED FISH).
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

Appendix 6. Rationale for choosing the factors that were used to adjust the numbers of salmon counted in the snorkelling survey, in 2001, to account for the salmon that were not observed.

Crabbes River:

Section 1: Adjustment Factor - 1.20
There was complete coverage of the entire Section. Salmon were only observed in 2 pools. The main stem of the river below the trestle, as in past years was not surveyed in 2001. A major tributary (Little Crabbes Brook) in this section was surveyed between July 21 and 30 and 2 salmon were observed. On October 1, there were 80 salmon (unsized) observed in Little Crabbes Brook below the culvert at Trans Canada Highway. Thus, there appears that additional salmon entered Crabbes River after the swim through survey.

Section 2: Adjustment Factor - 1.10
There was complete coverage of this Section and visibility was excellent. All salmon were observed in 2 pools. Nine snorkellers were used for one wide pool that had a large number of salmon. Some salmon may have been missed.

Section 3: Adjustment Factor - 1.00
Coverage of this section was complete. 100% of fish were seen in 1 pool. 5 divers had excellent visibility.

Section 4: Adjustment Factor - 1.15
Visibility was excellent (10 m), and there was complete coverage of the main stem. 98% of fish were seen in 2 pools. There is one relatively large tributary with a difficult falls of which only the lower 1.5 km was surveyed. Only two salmon were observed. Water level was low.

Section 5: Adjustment factor - 1.00
Visibility was excellent (7 m), and there was complete coverage of the Gorge. Twelve salmon were seen in all. Three divers used.

Section 6: Adjustment factor - 1.00
There was complete coverage of all pools. Excellent visibility of 10 meters. Pools were all <3 m in depth.

Section 7: Adjustment factor - 1.10
Complete coverage of most pools. 1 pool had a maximum depth of 8.0 meters where some fish may have been missed.

Middle Barachois Brook:

Section 1: Adjustment Factor - 1.00
No salmon observed. All pools were surveyed. Visibility > 7 m.

Section 2: **Adjustment Factor - 1.10**
Large number of salmon in 1 pool (367, which was an estimate. Visibility was very good 5-10 m. Complete counts in all other pools. There may be some salmon in tributaries.

Section 3: **Adjustment factor - 1.10**
Complete counts were made in all pools. Visibility was very good, approximately 4 to 6 m. Sands Pool is difficult to survey due to its depth and configuration. Three pools were 3 m to 4 m in depth. There may be some salmon in tributaries.

Section 4: **Adjustment factor - 1.05**
All pools were shallow and there were sufficient snorkellers to survey the entire width of all pools. 1 pool (Elbow Pool) had 86% of fish. Good visibility. Snorkellers felt that there were complete counts in all pools. There may been some salmon missed in tributaries.

Section 5: **Adjustment factor - 1.20**
1 pool was too deep to see bottom, which was a partial count. This section has a lot of standing water where fish may be holding up from being an early run river.

Robinson's River:

Section 1 **Adjustment Factor - 1.10**
Majority of fish were seen in 2 pools near TCH. There were complete counts in all pools with 2 & 3 divers with good visibility. May have missed a few fish in tributaries.

Section 2: **Adjustment Factor - 1.10**
Surveyors considered counts to be complete in all pools. About 97% of salmon were in two pools. Pools were all 2 m or less in depth and the bottom could be seen in all of them. 10m visibility. May have missed a few fish in tributaries.

Section 3: **Adjustment factor – 1.05**
Complete count with 90% of salmon seen in 1 of 2 pools. . Maximum depth of 2 m. with 8 m. visibility. Large boulders in 1 pool where snorkellers may have missed some fish.

Section 4: **Adjustment factor - 1.15**
Counts were considered complete in all but 2 pools. One pool, although it had 1 m depth there were a large amount of fish (338), which may have been under counted. The pool at the base of the falls had a maximum depth of approximately 15 m, but visibility was only about 12 m; thus the number of salmon may have been undercounted.

Northern Feeder: **Adjustment factor - 1.00**

This Tributary was surveyed in 2 days. Water levels were low and the walkers didn't think they missed any fish.

Fischells Brook:

Section 1: Adjustment Factor - 1.00
All salmon seen in one pool. Total of 8 pools in Section. Visibility was good with complete coverage of all pools. Resurveyed on August 28 after 2 high water level evens and two salmon fewer than the original survey (Aug 12) were observed. No bright salmon were observed in the second survey

Section 2: Adjustment Factor - 1.00
There was complete coverage of this section. Water levels were extremely low and visibility was excellent. Most of the salmon were seen in 1 pool.

Section 3 (Steadies): Adjustment factor - 1.05
Complete coverage. Very few pools contained salmon. Water velocity was low. The deepest pool was about 5m, but there was no problem seeing the bottom or salmon n the pool due to the excellent visibility.

Section 4: Adjustment factor – 1.05
Complete count in all pools, but may have undercounted in 1 pool that had 80 fish total.

Section 5: Adjustment factor – 1.00
Fish were counted in 1 pool with 2 divers. Pool was 5 meters in depth and visibility was 5m.

Flat Bay Brook:

Section 1: Adjustment Factor – 1.10
Three snorkellers were used. Good coverage. There were 2 pools > 30m wide where some fish may have been missed. The maximum depth in these pools was 2.5 m.

Section 2: Adjustment Factor - 1.10
Twelve snorkellers surveyed most of this section. Excellent water clarity in all pools. One pool was 15 m deep where some fish may have been missed. This section was done in two days to break up the time required for total concentration to properly survey the wide, deep pools.

Section 3: Adjustment Factor - 1.10
There were 8 snorkellers used but 3 to 5 needed for most pools. Good coverage except for 1 pool that had large boulders in it making it difficult to get a total count. Some fish behind rocks may have missed. The number of salmon had to be estimated.

Section 4: Adjustment factor - 1.00
Two snorkels easily counted salmon in this section. All fish were seen in 1 of the pools where salmon were observed in previous years just below a cascade, where 1 diver could count the salmon. Maximum depth was 2.5 m

Section 5: Adjustment factor – 1.20

Fish were only observed in 3 pools in this section. Fish had to be estimated in two of these pools. Salmon were crowded together making it difficult to get an accurate count. Divers thought they had a good estimate. There is a wide, deep gorge at the start of this section that was surveyed this year for the first time. No fish were detected, but there some could have been missed.

Appendix 7. Results of test to assess snorkeller biases in sizing and counting salmon. There were 36 model salmon, of which 10 were large (> 63 cm) and 26 were small (<63 cm) salmon

Snorkeller	Large Salmon		Small Salmon		Total	
	# Counted	% Diff from actual #	# Counted	% Diff from actual #	# Counted	% Diff from actual #
1	8	-20.0	27	3.8	35	-2.8
2	5	-50.0	31	19.2	36	0.0
3	8	-20.0	28	7.7	36	0.0
4	6	-40.0	30	15.4	36	0.0
5	9	-10.0	27	3.8	36	0.0
6	13	30.0	23	-11.5	36	0.0
7	11	10.0	23	-11.5	34	-5.6
8	7	-30.0	30	15.4	37	2.8
9	11	10.0	22	-15.4	33	-8.3
Mean	8.7	-13.3	26.8	3.0	35.4	-1.5
SD	2.6	26.0	3.4	13.0	1.2	3.4
95% CL	1.7	17.0	2.2	8.5	0.8	2.2

Test method: Thirty-six wooden fish (10 were > 63 cm and 26 were <63 cm) cut the shape of a salmon and stained a dark colour, to give some resemblance of natural salmon, were place in a river in water depths ranging from 2 m to 3 m. The fish were attached to a metal rod with a nylon string about 0.5 m in length, which this allowed the fish to float up to 0.5 m off the bottom. The fish were placed approximately 0.5 m apart in a relatively straight line down stream. Water velocity was not measured, but it was estimated to be < 0.5 m/sec, and visibility was > 5 m. Snorkellers floated down the river and counted the wooden fish as large (> 63 cm) or small (< 63 cm). The test was conducted near the end of the river surveys. The fork-lenght of the test fish were as follows: 14 were 50cm, 6 were 55 cm, 6 were 58 cm, 5 were 68 cm. and 5 were 77 cm.